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ABSTRACT

These American Indian standards for mathematics were developed by the Bureau of Indian Affairs (BIA) for use by classroom teachers of American Indian students. They have been closely aligned with the 1989 "Curriculum and Evaluation Standards for School Mathematics," national standards currently in use in many BIA-funded schools. Each standard describes what mathematics should be included in the curriculum and possible student activities associated with that mathematics. Like the national standards, the American Indian standards are organized into grade level groupings of K-4, 5-8, and 9-12. The first four standards for each grade grouping cover problem solving, communication, reasoning, and mathematical connections. Other K-4 standards cover estimation, number sense and numeration, concepts of whole number operations, whole number computation, geometry and spatial sense, measurement, statistics and probability, fractions and decimals, and patterns and relationships. Other 5-8 standards cover number and number relationships, number systems and theory, computation and estimation, patterns and functions, algebra, statistics, probability, geometry, and measurement. Other 9-12 standards cover algebra, functions, geometry from synthetic and algebraic perspectives, and statistics. This document may also be used by American Indian nations as a guideline for developing tribally specific local standards. (SV)

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ED 420 487

AMERICAN INDIAN STANDARDS FOR MATHEMATICS EDUCATION

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Bureau of Indian Affairs

Aligned with the 1989 Curriculum and Evaluation Standards for School Mathematics developed by the National Council of Teachers of Mathematics

RC 021594

American Indian Standards for MATHEMATICS EDUCATION

Introduction

These *American Indian Standards for Mathematics* have been developed by the Bureau of Indian Affairs for use by classroom teachers of American Indian students. They have purposely been closely aligned with the 1989 *Curriculum and Evaluation Standards for School Mathematics* (developed by the National Council of Teachers of Mathematics) since many BIA-funded schools are currently using the national standards as a foundation for developing local standards.

Each Standard states what mathematics should be included in the curriculum as well as a description of possible student activities associated with that mathematics. Like the national standards themselves, the American Indian Standards are broken into grade level groupings of K-4, 5-8 and 9-12. The first four standards for each grade grouping are labeled "Problem Solving," "Communication," "Reasoning" and "Mathematical Connections." The remaining standards in each grade grouping emphasize either content which is specific to that grade level grouping or content that is across the K-12 mathematics curriculum.

The reader should note that all *italicized* words in this document have been taken directly from the national standards. For the most part, the Indian specific language appears in the bulleted student activity level immediately following the standard itself. Teachers using these American Indian Standards will probably find the "Focus" and "Discussion" sections of the National Standards document useful for generating ideas about instruction and ways to encourage broader student thinking.

Although the Bureau of Indian Affairs has developed these American Indian Standards with the hope that they will be useful for schools serving Indian students, the BIA also encourages each Indian nation to consider development of its own local standards to reflect specific cultural factors pertinent to individual communities. For those tribes which choose to pursue that course of action, these Standards may serve as useful samples and guidance.

We note that these Standards should be considered "a work in progress." As such, they will periodically be improved and revised by the BIA, based on input from American Indian educators and leaders. Please send any comments you might have to:

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Grade K-4

AMERICAN INDIAN STANDARDS FOR MATHEMATICS EDUCATION

STANDARD 1: *MATHEMATICS AS PROBLEM SOLVING*

In grades K-4, the study of mathematics should emphasize problem solving so that Indian *students can:*

- formulate problems from everyday and mathematical situations within their home and tribal/community worlds.
- acquire confidence in using mathematics meaningfully through understanding that American Indians have always realized the importance of mathematical concepts and problem solving and have contributed to the field of mathematical content.

STANDARD 2: *MATHEMATICS AS COMMUNICATION*

In grades K-4, the study of mathematics should include numerous opportunities for communication so that Indian *students can:*

- relate physical materials, pictures, and diagrams to mathematical ideas utilizing beadwork, pottery, baskets, rugs, star quilts, and other items from American Indian cultures.
- relate their everyday language to mathematical language and symbols including expressing mathematical concepts (counting, time, volume, etc.) in their Native languages, and using Native symbols, if existing.
- realize that representing, discussing, reading, writing, and listening to mathematics are vital parts of learning and using mathematics because it creates holistic instruction akin to a traditional Indian approach to learning and can draw from ideas found in Native American literature or other Native content.

STANDARD 3: *MATHEMATICS AS REASONING*

In grades K-4, the study of mathematics should emphasize reasoning so that Indian *students can:*

- use models, known facts, properties and relationships to explain their thinking, taking objects or ideas from their own or other American Indian cultures to do so.
- believe that mathematics makes sense within their home and tribal/community worlds and articulate examples of how it makes sense.

STANDARD 4: *MATHEMATICAL CONNECTIONS*

In grades K-4, the study of mathematics should include opportunities to make connections so that Indian *students can:*

- use mathematics in other curriculum areas by developing their own story problems derived from American Indian themes, or by calculating distances on maps related to Indian history, etc.

STANDARD 5: *ESTIMATION*

In grades K-4, the curriculum should include estimation so that Indian *students can:*

- explore estimation strategies through activities derived from their cultural worlds, such as estimating the number of sheep/horses that fit in a pen/corral, or the number of fraction of "hanks" it will take to bead an item.

- recognize when estimation is appropriate through practice activities which demonstrate that Indian people in the past used estimation when trading for goods, when measuring, etc.

- apply estimation when working with quantities, measurement, computation and problem solving with hands-on experience in creating Indian arts/crafts items.

STANDARD 6: NUMBER SENSE AND NUMERATION

In grades K-4, the mathematics curriculum should include whole number concepts and skills so that Indian *students can:*

- construct number meanings through real-world experiences and use of physical materials drawing upon both designs from Indian artwork for examination and numerical analysis as well as manipulatives derived from Indian crafts (beads) or traditional foods (dried corn kernels, beans) for practice.

- understand the numeration system by relating counting, grouping, and place value concepts and reinforcing these concepts by becoming familiar with the Inca and Mayan systems.

- interpret the multiple use of numbers encountered in the real world including the significance of certain numbers such as four and seven for many American Indian tribes.

STANDARD 7: *CONCEPTS OF WHOLE NUMBER OPERATIONS*

In grades K-4, the mathematics curriculum should include the concepts of addition, subtraction, multiplication and division of whole numbers so that Indian *students can:*

- develop meaning for the operations by modeling and discussing a rich variety of problem situations including some from the Indian world such as those associated with scoring in American Indian games (e.g., dice, hand, and stick games), and problems derived from American Indian literature and history.

STANDARD 8: *WHOLE NUMBER COMPUTATION*

In grades K-4, the mathematics curriculum should develop whole number computation so that Indian *students can:*

- use a variety of mental computation and estimation techniques in solving problems related to Indian cultural themes.

STANDARD 9: *GEOMETRY AND SPATIAL SENSE*

In grades K-4, the mathematics curriculum should include two and three-dimensional geometry so that Indian *students can:*

- describe, model, draw and classify shapes including tribal design, symbols and traditional structures (such as the conical shape of the tipi).
- investigate and predict the results of combining, subdividing and changing shapes such as those found in star quilt designs.
- relate number and measurement ideas by counting, measuring and performing other functions related to geometric designs found in American Indian art.
- recognize and appreciate geometry in their world especially that found in Indian arts and crafts and the significance of certain shapes, such as the circle, to Indians.

STANDARD 10: *MEASUREMENT*

In grades K-4, the mathematics curriculum should include measurement so that Indian *students can:*

- understand the attributes of length, capacity, weight, mass, area, volume, time, temperature and angle and relate these measures to use in their own cultural, home, tribal or community worlds.

- develop the process of measuring and concepts related to units of measurement including examples of measurement in Indian art and architecture and other aspects of Indian life.

- make and use measurements in problem and everyday situations such as cooking and Indian foods or creating Indian arts and crafts.

STANDARD 11: *STATISTICS AND PROBABILITY*

In grades K-4, the mathematics curriculum should include experience with data analysis and probability so that Indian *students can:*

- collect, organize and describe data related to local tribal/community demographics.

- construct, read and interpret displays of data relate to local tribal/community demographics.

- explore concepts of chance including those related to Indian stick and hand games.

STANDARD 12: *FRACTIONS AND DECIMALS*

In grades K-4, the mathematics curriculum should include fractions and decimals so that Indian *students can:*

- apply fractions and decimals using Native language terms and applying them to real world situations using Native cultural experiences.

STANDARD 13: *PATTERNS AND RELATIONSHIPS*

In grades K-4, the mathematics curriculum should include the study of patterns and relationships so that Indian *students can:*

- represent and describe mathematical relationships utilizing patterns found in Indian art and design.

Grades 5-8

AMERICAN INDIAN STANDARDS FOR MATHEMATICS EDUCATION

STANDARD 1: *MATHEMATICS AS PROBLEM SOLVING*

In grades 5-8, the mathematics curriculum should include numerous and varied experiences with problem solving as a method of inquiry and application so that Indian *students can:*

- use problem-solving approaches to investigate and understand mathematical content and relate it to the American Indians' application of mathematical knowledge, for example, the use of symmetry in traditional beadwork designs.

- develop and apply a variety of strategies to solve problems, with emphases on multistep and nonroutine problems and relate problem solving to community or Tribal economic issues.

STANDARD 2: *MATHEMATICS AS COMMUNICATION*

In grades 5-8, the study of mathematics should include opportunities to communicate so that Indian *students can:*

- model situations using oral, written, concrete, pictorial, graphical, and algebraic materials based on early American Indian trading and bartering systems.

- discuss mathematical ideas and make conjectures and convincing arguments such as explaining the use of various geometric figures in the design of traditional American Indian homes.

- appreciate the value of mathematical notation and its role in the development of mathematical ideas through conducting simple exercises in using Mayan base 5-20 number system as compared to Hindu-Arabic base 10 system.

STANDARD 3: *MATHEMATICS AS REASONING*

In grades 5-8, reasoning shall permeate the mathematics curriculum so that Indian *students can:*

- recognize and apply inductive and deductive reasoning an relate reasoning to applicable statistics such as that which pertains to an economic base -- tourism, timber, manufacturing, fishing, crafts, etc.

STANDARD 4: ***MATHEMATICAL CONNECTIONS***

In grades 5-8, the mathematics curriculum should include the investigation of mathematical connections so that Indian *students can:*

- explore problems and describe results using graphical, numerical, physical, algebraic, and verbal mathematical models or representations and relate problems to tribal demographics.
- apply mathematical thinking and modeling to solve problems that arise in other disciplines, such as American Indian music, art, and tribal-related business.
- value the role of mathematics in our culture and society, especially in their tribal communities.

STANDARD 5: ***NUMBER AND NUMBER RELATIONSHIPS***

In grades 5-8, the mathematics curriculum should include the continued development of number and number relationships so that Indian *students can:*

- understand, represent, and use numbers in a variety of equivalent forms (integer, fraction, decimal, exponential; and scientific notation) in real-world and mathematical problem situations; use articles from tribal or national Indian newspapers to generate practice problems.

STANDARD 6: ***NUMBER SYSTEMS AND NUMBER THEORY***

In grades 5-8, the mathematics curriculum should include the study of number systems and number theory so that Indian *students can:*

- understand the basic arithmetic operations are related to one another and relate them to the American Indian concept of balance -- i.e., addition is the opposite of subtraction, multiplication is repeated addition and division is the opposite of multiplication and repeated subtraction.

STANDARD 7: ***COMPUTATION AND ESTIMATION***

In grades 5-8, the mathematics curriculum should develop the concepts underlying computation and estimation in various contexts so that Indian *students can:*

- use computation, estimation, and proportions to solve problems at home and in the tribal community.

STANDARD 8: ***PATTERNS AND FUNCTIONS***

In grades 5-8, the mathematics curriculum should include explorations of patterns and functions so that Indian *students can:*

- describe, extend, analyze, and create a wide variety of patterns related to American Indian artistic and functional designs.

STANDARD 9: ***ALGEBRA***

In grades 5-8, the mathematics curriculum should include explorations of algebraic concepts so that Indian *students can:*

- apply algebraic methods to solve a variety of problems in their home/Tribal worlds and relative to the students' personal interests.

STANDARD 10: ***STATISTICS***

In grades 5-8, the mathematics curriculum should include exploration of statistics in real-world situations so that Indian *students can:*

- systemically collect, organize, describe data and create a database from local tribal or national Indian demographic information that is relevant.
- construct, read, and interpret tables, charts and graphs based on historical and contemporary American Indian subject matter -- e.g., demographic trends among American Indian populations by state from the mid 1800's to today.
- make inferences and convincing arguments that are based on analysis of data they have assembled on American Indian subject matter.
- develop an appreciation for statistical methods as powerful means for decision making presented through examples utilized by the tribal council/community and creating databases through a partnership with community and government agencies.

STANDARD 11: ***PROBABILITY***

In grades 5-8, the mathematics curriculum should include explorations of probability in real world situations so that Indian *students can:*

- devise and conduct experiments or simulations to apply probabilities concepts/principles to tribal economic development and other community interests.

- appreciate the power of probability models by comparing the results of experimental simulations and probability expectations, related to projected revenue generated from tribal enterprises or classroom enterprises, such as a raffle sale.

- make predictions that are based on experimental or theoretical probabilities and relate the experiments to tribal or national Indian demographical information, and school and classroom demographics.

STANDARD 12: *GEOMETRY*

In grades 5-8, the mathematics curriculum should include the study of the geometry of one, two, and three dimensions in a variety of situations so that Indian *students can:*

- identify, describe, compare, and classify geometric figures from various American Indian art forms to learn concepts related to plane and solid geometry. (Examples -- Seminole patch work quilting, Lakota star quilts, Pueblo pottery designs)

- use geometric figures to develop spatial sense by designing their own geometric models/designs which emulate traditional American Indian art forms.

STANDARD 13: *MEASUREMENT*

In grades 5-8, the mathematics curriculum should include extensive concrete experiences using measurement so that Indian *students can:*

- understand the structure and use of systems of measurement related to historical American Indian bartering systems and community housing authorities and other present day tribal/community applications of measurement.

- extend their understanding of the concepts of perimeter, area, volume, angle measure, capacity, and weight and mass as they relate to an examination of traditional American Indian objects, such as pottery, drums, rattles, or baskets.

Grades 9-12

AMERICAN INDIAN STANDARDS FOR MATHEMATICS EDUCATION

STANDARD 1: *MATHEMATICS AS PROBLEM SOLVING*

In grades 9-12, the mathematics curriculum should include the refinement and extension of methods of mathematical problem solving so that Indian *students can:*

- apply integrated mathematical problem-solving strategies, within the context of problems related to tribal community activities, school situations, classroom projects, and group participants' shared interests.
- apply the process of mathematics modeling to real-world problem situations, such as tribal road-building projects, or quantifying data on water or other tribal resources.

STANDARD 2: *MATHEMATICS AS COMMUNICATION*

In grades 9-12, the mathematics curriculum should include the continued development of language and symbolism to communicate mathematical ideas so the Indian *students can:*

- appreciate the economy, power, and elegance of mathematical notation and its role in the development of mathematical ideas applied to tribal situations.
- realize one's own contribution to the tribe as it relates to promoting the local tribe's economic and technological growth.
- understand the power of mathematical representation to preserve tribal human and natural resources.

STANDARD 3: *MATHEMATICS AS REASONING*

In grades 9-12, mathematics should include numerous and varied experiences that reinforce and extend logical reasoning skills so that Indian *students can:*

- make and test conjectures in context of issues related to their own tribal community.
- formulate counterexamples (comparing to other tribes).
- judge the validity of arguments (don't avoid moral dilemmas).
- construct simple valid arguments (link to positions of various members in a community).

STANDARD 4: ***MATHEMATICAL CONNECTIONS***

In grade 9-12, the mathematics curriculum should include investigation of the connections and interplay among various mathematical topics and their applications (applications that are created by the students themselves) *so that* Indian *students can:*

- use and value the connections among mathematical topics (link to study of tribal kinship systems).

- use and value the connections between mathematics and other disciplines. Students should find mathematics in various disciplines with a connection to American Indian topics, such as social studies, tribal history, literature/art/music, tribal language and ethnosciences.

STANDARD 5: ***ALGEBRA***

In grades 9-12, the mathematics curriculum should include the continued study of algebraic concepts and methods so that Indian *students can:*

- represent situations (germane to particular tribe or intertribal community) that involve variable quantities with expressions, equations, inequalities, and matrices.

STANDARD 6: ***FUNCTIONS***

In grades 9-12, the mathematics curriculum should include the continued study of functions so that Indian *students can:*

- model real-world phenomena with a variety of functions and represent and analyze relationships using tables, verbal rules, equations, and graphs, such as in the growth of tribal gross national product or individual incomes as a function of tribal economic ventures.

STANDARD 7: ***GEOMETRY FROM A SYNTHETIC PERSPECTIVE***

In grades 9-12, the mathematics curriculum should include the continued study of geometry of two and three dimensions so that Indian *students can:*

- interpret and draw three-dimensional objects of an American Indian cultural nature, using appropriate tools including computers.

- classify figures in terms of congruence and similarity and apply these relationships (include opportunities for students to identify their own findings from local tribal/intertribal experiences).

STANDARD 8: *GEOMETRY FROM AN ALGEBRAIC PERSPECTIVE*

In grades 9-12, the mathematics curriculum should include the study of the geometry of two and three dimensions from an algebraic point of view so that Indian *students can:*

- identify congruent and similar figures using transformations (relating Indian beadwork designs to Pascal's Triangle).

STANDARD 10: *STATISTICS*

In grades 9-12, the mathematics curriculum should include the continued study of data analysis and statistics so that Indian *students can:*

- construct and draw inferences from charts, tables, and graphs that summarize data from real-world situations, such as tribal/intertribal newspapers or reports and advertising related to Indian communities.
- understand and apply measures of central tendency, variability, and correlation in statistical data related to their tribe.
- design a statistical experiment to study a tribally-related problem, conduct the experiment, and interpret and communicate the outcomes (to show as "whole project" to parents, public, use presentation software).

National Standards NOT Included in this document:

Standard 9: *Trigonometry*
Standard 11: *Probability*
Standard 12: *Discrete Mathematics*
Standard 13: *Conceptual Underpinnings of Calculus*
Standard 14: *Mathematical Structure*